Characterization of the vertical structure of the atmosphere using ground-based remote sensing (III)

C. Yballa Hernández Pérez

PROJECT 3
(Call 2011)

Training in remote instrumental techniques (ground-based remote sensing) for detection and study of reactive gases and atmospheric aerosols

Tutor: Dr. Emilio Cuevas Agulló
Supervisors: Dr. Alberto Berjón Arroyo, Dr. Silvia Alonso Pérez

3rd October, 2014

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  - Micro Pulse Lidar
  - Ceilometer
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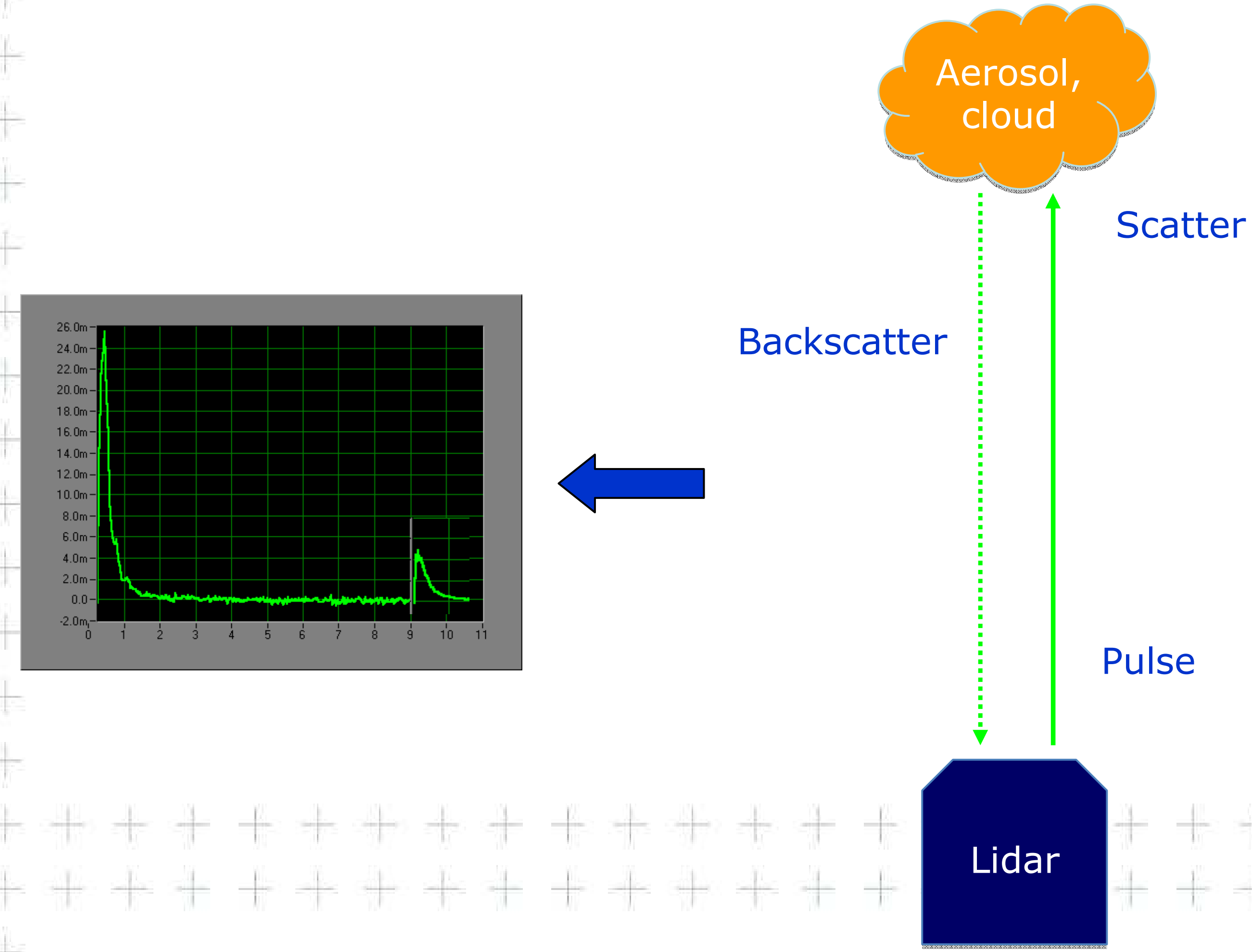
Introduction

- Lidar → capable of providing vertical profiles of aerosol and cloud structure



-Lidar

Micro Pulse Lidar (MPL-3)

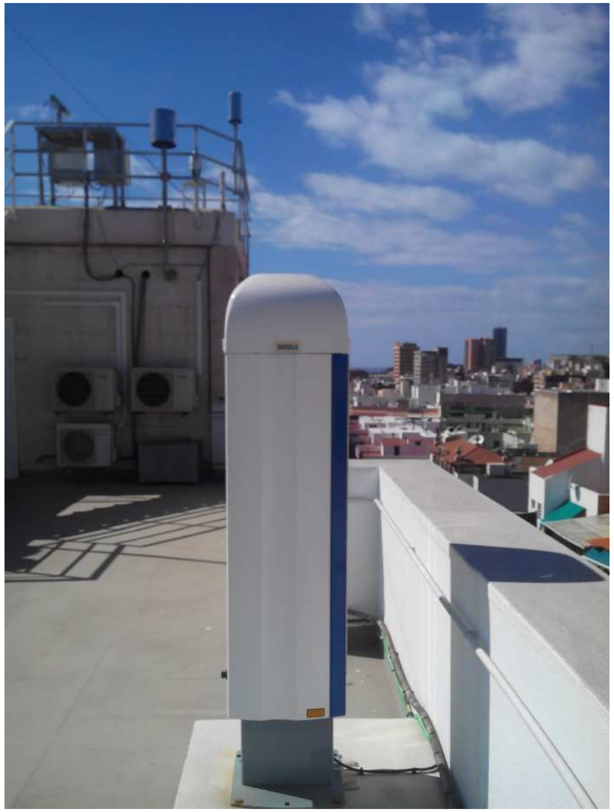
- ✓ **CIAI (AEMET) and INTA co-manage the MPL-3**
- ✓ **523.5 nm**
- ✓ **7 µJ**
- ✓ **'eye-safe'**

http://mplnet.gsfc.nasa.gov.

www.lidar.es/spalinet/es/

GALION www.wmo.int/gaw/**galion**/index.html

-Ceilometer Vaisala CL51

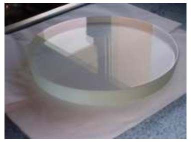


- ✓ Compact and robust lidar system
- ✓ Operates in extreme weather conditions
- ✓910 nm
- ✓ 3 µJ
- ✓ ‘eye-safe’

Maintenance, calibrations and evaluation of data, MPL-3

Maintenance

- ✓ Temperature control : laser, telescope, detector, location…
- ✓ Humidity control
- ✓ Cleaning of optics
- ✓ Daily checking list



10%

Calibrations

- ✓ Darkcurrent (monthly)
- ✓ Afterpulse (monthly)
- ✓ Overlap (once a year)

20%

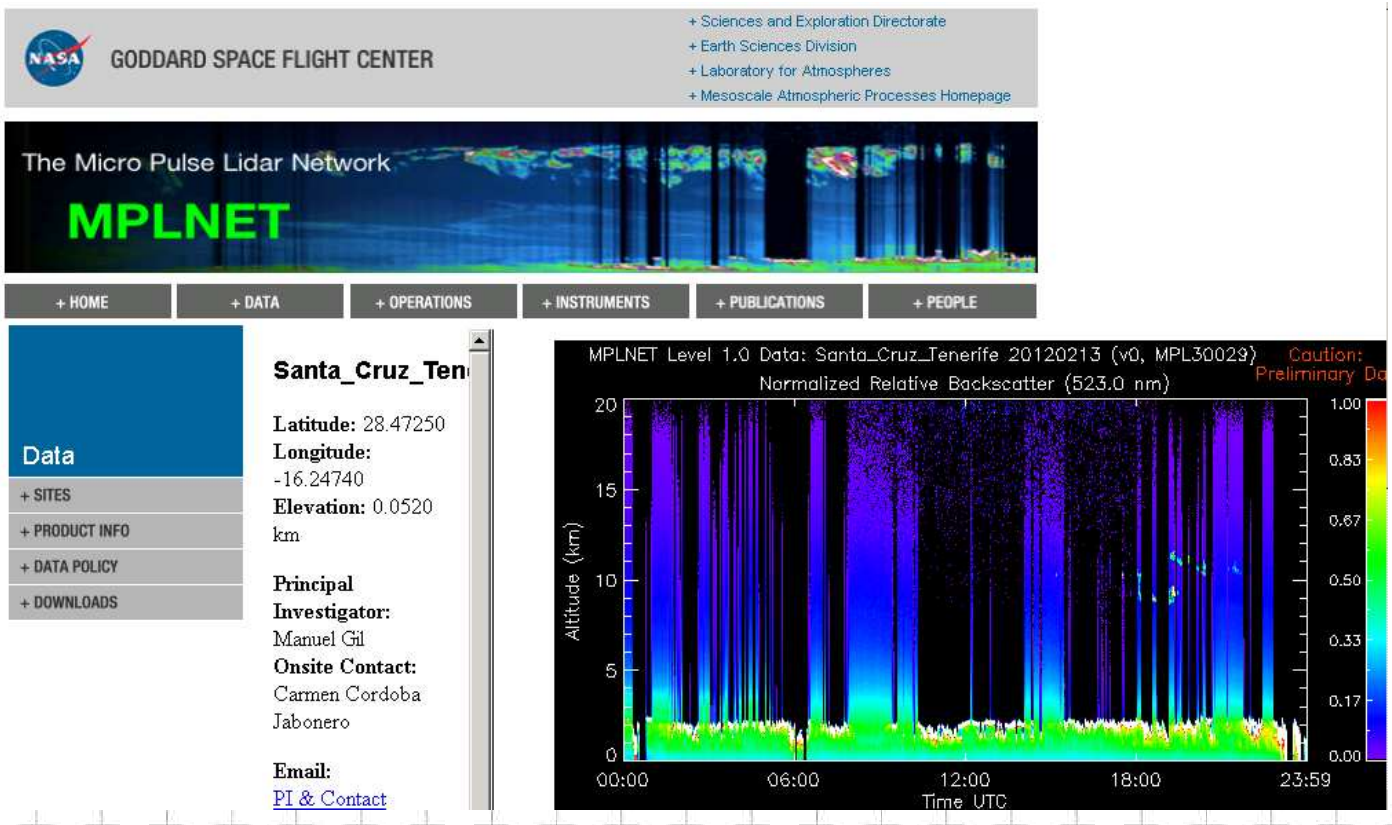
Data evaluation

- ✓ Calibrations
- ✓ Measurements

70%

Maintenance, calibrations and evaluation of data, MPL-3

Sending daily files of Lidar data to MPLNET



http://mplnet.gsfc.nasa.gov/dat.htlm

Maintenance, calibrations and evaluation of data, Vaisala CL51

Maintenance	✓ Overall control of the instrument ✓ Cleaning of optics ✓ Daily checking list	40%
Calibrations	**X**	
Data evaluation	✓ Measurements: height of clouds, BL, aerosols	60%

Main Results (1/3)

- New afterpulse (AFP) correction MPL-3

$$P(r) = r^2 \frac{n(r) - A(r) - D - B}{O(r)E}$$

$$A(r) = \frac{E}{E_0} A_0(r)$$ (Welton and Campbell, 2002)

$$A(r) = F_r A_0(r)$$ (CIAI)

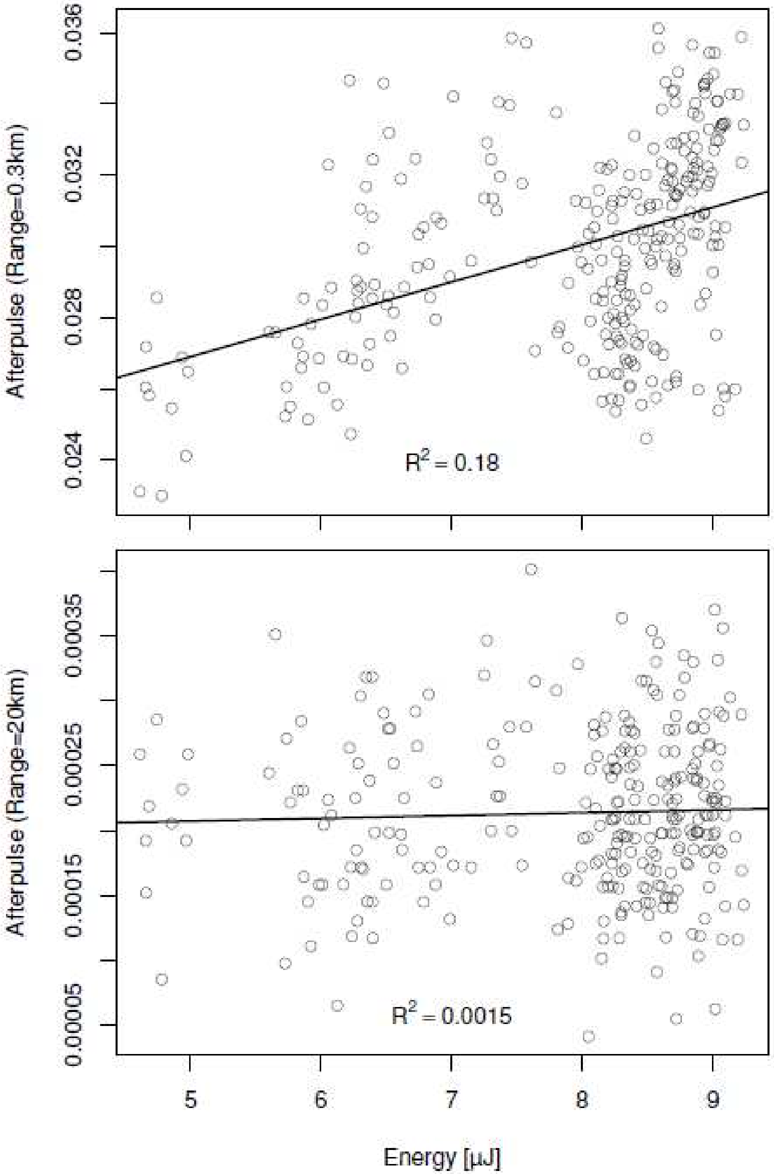
- Dependence of the AFP on output pulse energy

- Dependence of the AFP on obstacle reflectance

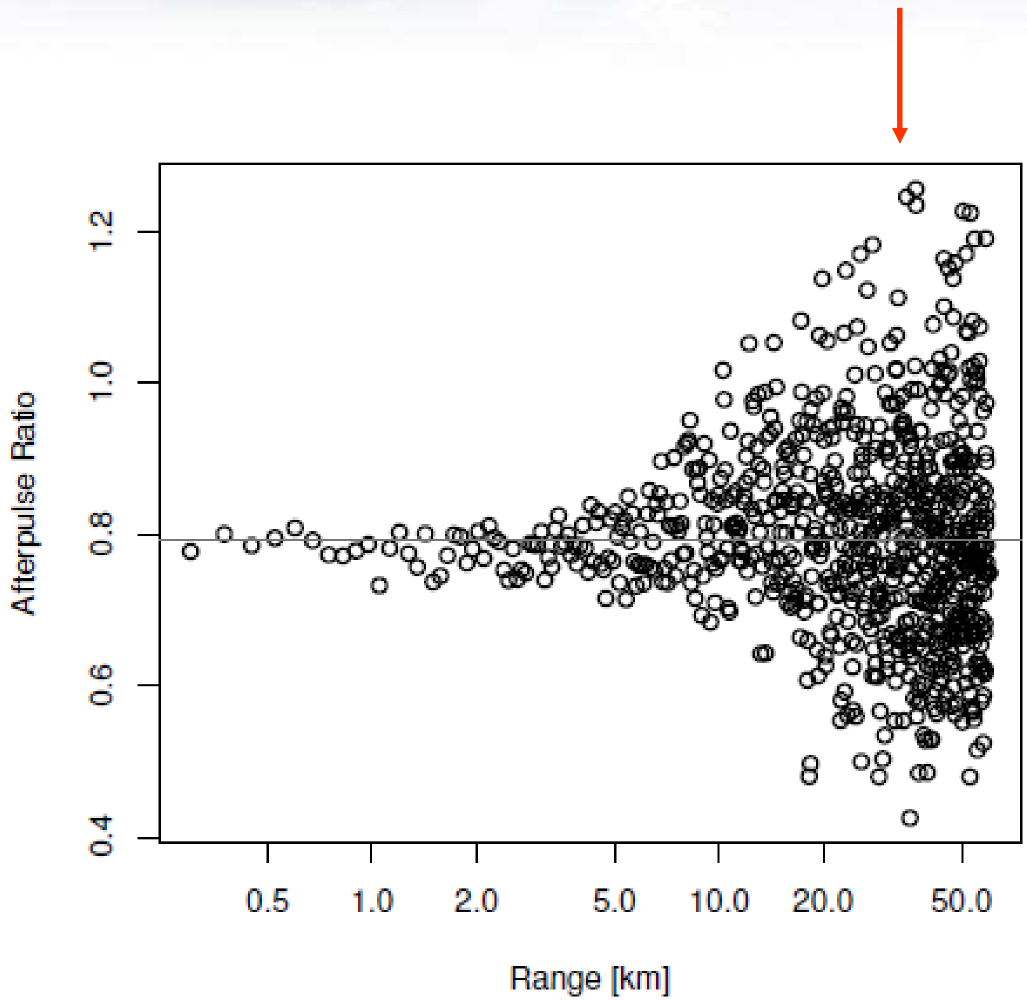
- Effect of AFP correction on MPL background

- Effect of AFP correction on the analysis of aerosol intrusion at high altitudes

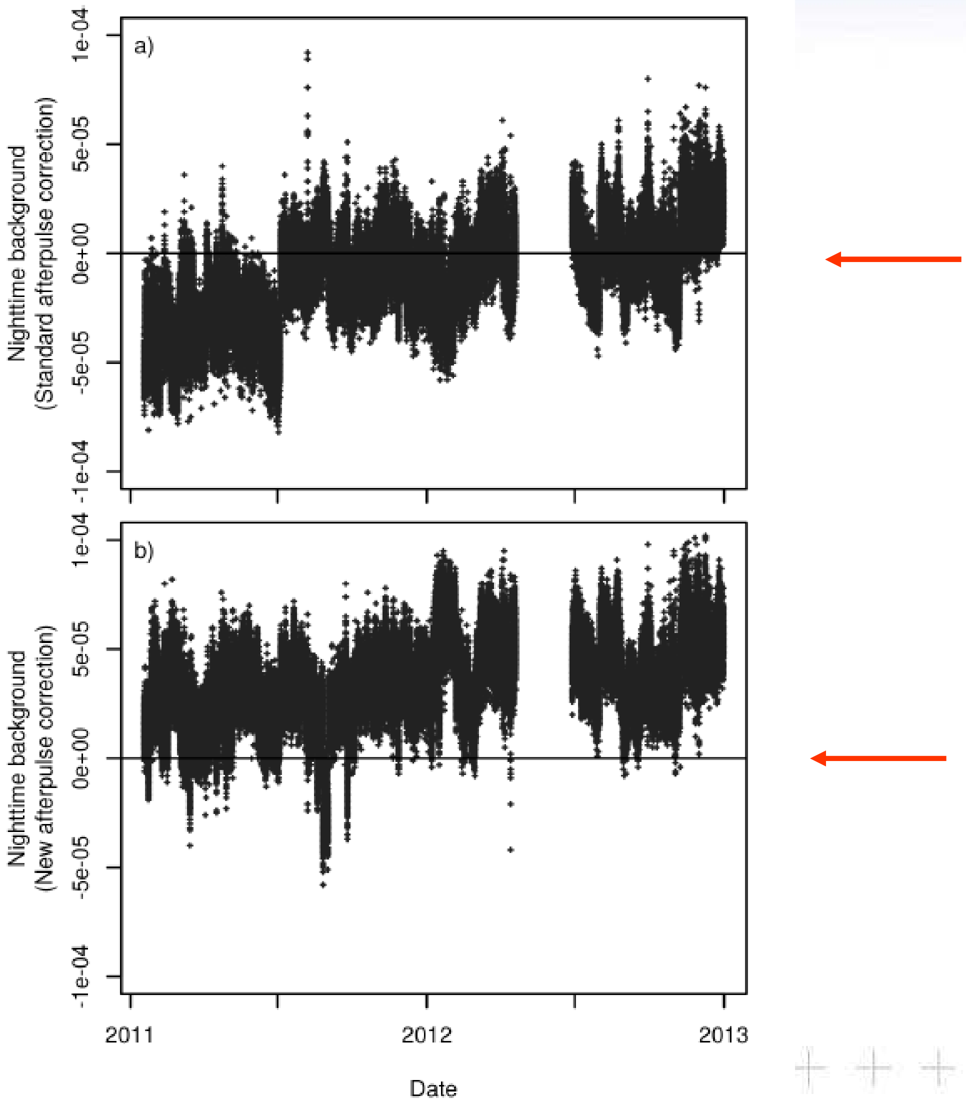
Dependence of the AFP on output pulse energy



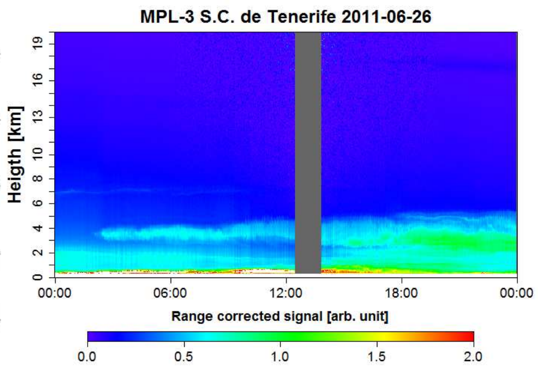
Dependence of the AFP on obstacle reflectance

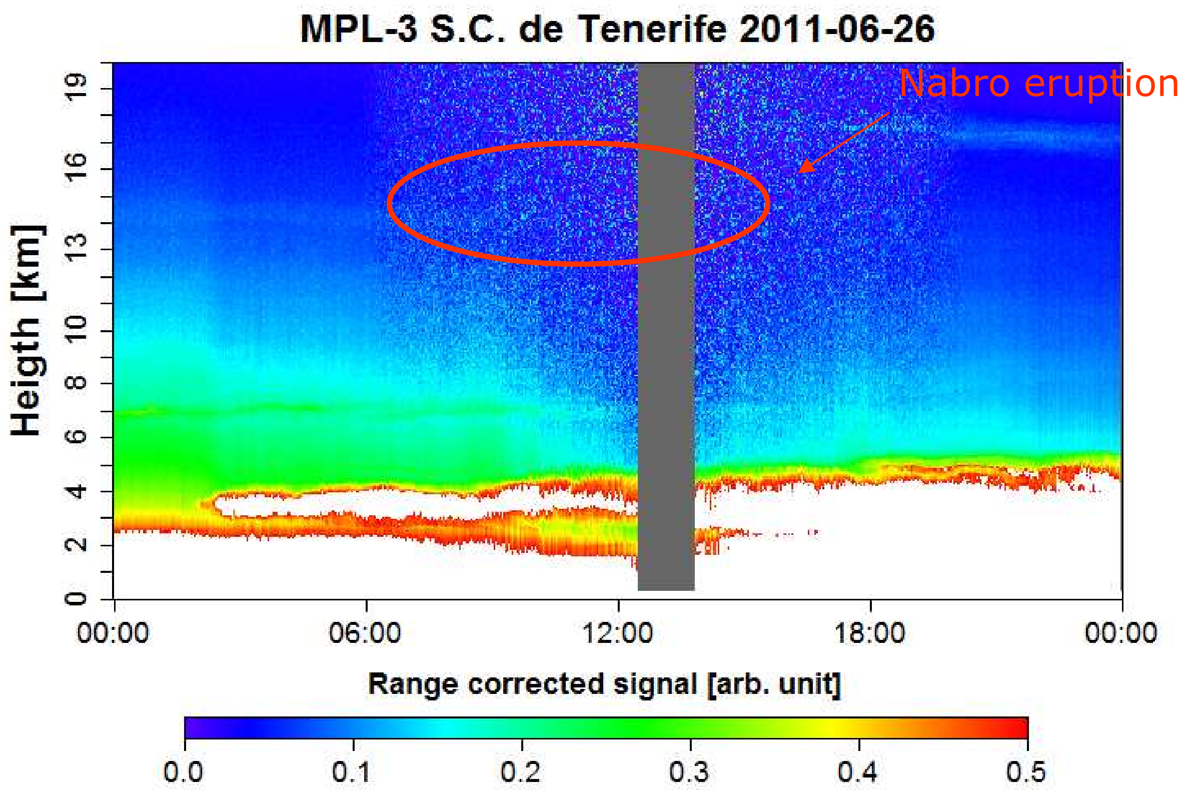


Effect of AFP correction on MPL background



Effect of AFP correction on the analysis of aerosol intrusion at high altitudes





AFP(Welton and Campbell;2002) → AOD=0.031+/-0.003 LR=80+/-6sr

AFP(CIAI) → AOD=0.021+/-0.002 LR=55+/-4sr

32% AOD

31% LR

Sawamura et al.,2012

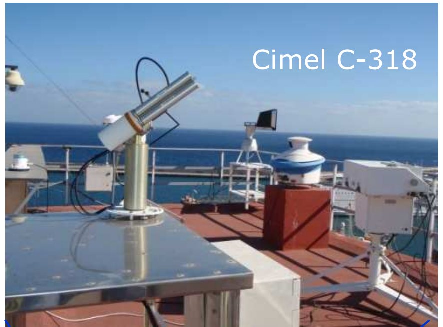
New afterpulse (AFP) correction MPL-3

Reprocessing of lidar data series → new algorithm

- Calibrations: darkcurrent, afterpulse, overlap
- Raw signal
- Range corrected signal
- Parameters: temperatures, energy,…
- Signal to noise ratio
- Mapping

Main Results (2/3)

- Inversion algorithm (Fernald 1984; Klett ,1985) “one layer”



$$P_{NRB}(r) = C\left(\beta_M(r) + \beta_P(r)\right) e^{-2\int_0^z \sigma_M(r')dr'} e^{-2\int_0^z \sigma_P(r')dr'}$$

- 3 unknowns

- To solve the problem:

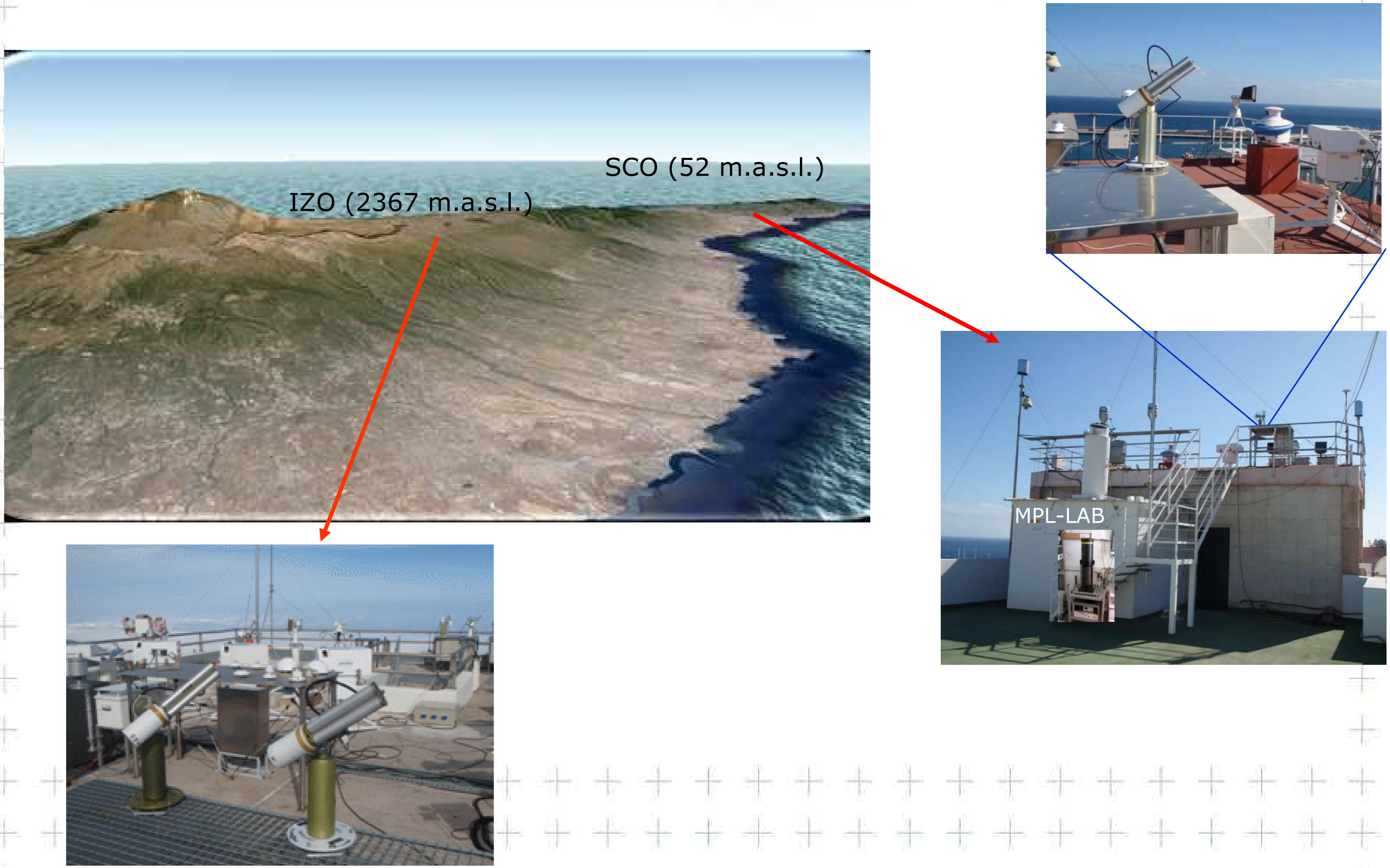
$Zref \longrightarrow \cancel{C}$

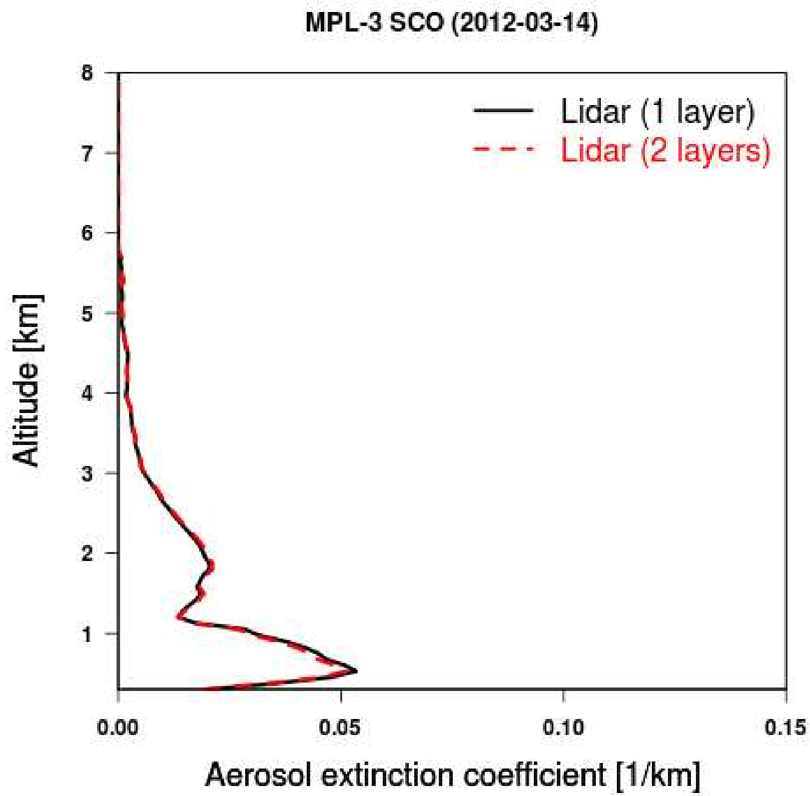
$LR=\sigma/\beta$

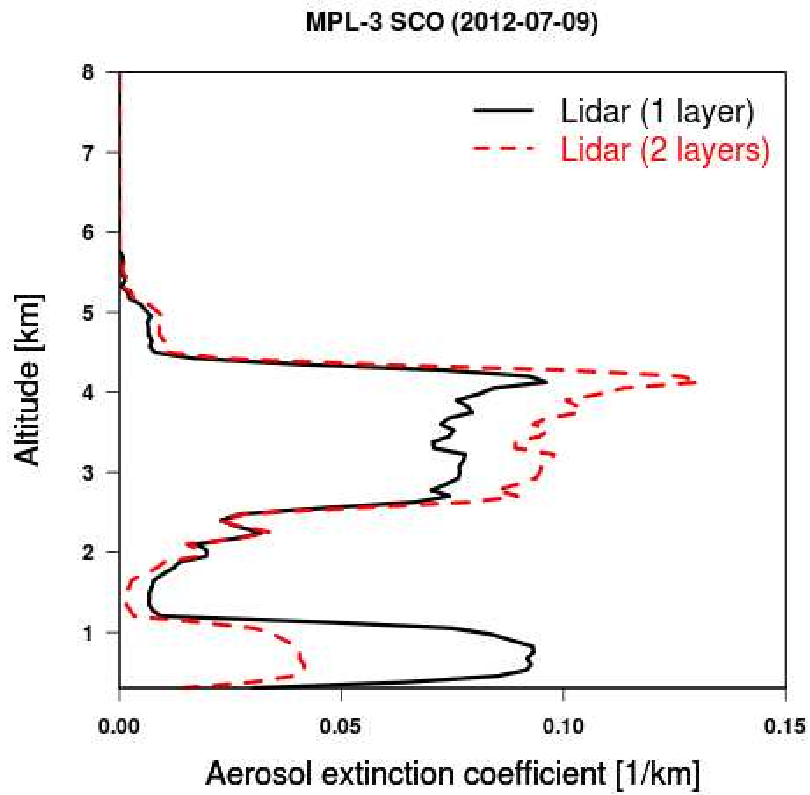
$AOD_{MPL} \approx AOD_{AERONET}$

Main Results (3/3)

- Inversion algorithm (Fernald 1984; Klett ,1985; Sasano,1985) “two layers”







Inversion	LR(sr)
One layer	24
Two layers	23 25

Marine	(LR=20-30 sr)
Mixed	(LR=30-45 sr)
Dust	(LR= 45-70 sr)

Inverrsion	LR(sr)
One layer	45
Two layers	21 63

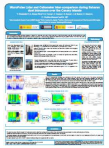
Müller et al.,2007 → FT LR=29 sr

Publications and Congress Communications, 2011-2014 (1/5)

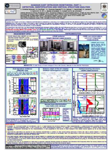
RECTA 2011

V Reunión Española de Ciencia y Tecnología de Aerosoles

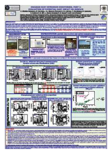
Madrid, 27 - 29 de Junio de 2011, CIEMAT



Hernández, Y., S. Alonso-Pérez, E. Cuevas, C. Camino, R. Ramos, J. de Bustos, C. Marrero, C. Córdoba-Jabonero, and M. Gil, MicroPulse Lidar and Ceilometer inter-comparison during Saharan dust intrusions over the Canary Islands, V Reunión Española de Ciencia y Tecnología de Aerosoles – RECTA 2011, CIEMAT, 27-29 Junio de 2011.



Córdoba-Jabonero, C., M. Sorribas, J.L. Guerrero-Rascado, J.A. Adame, **Y. Hernández**, H. Lyamani, V. Cachorro, M. Gil, L. Alados-Arboledas, E. Cuevas, and B. de la Morena, Saharan dust intrusion monitoring. Part 1: Detection, identification and vertical structure analysis, V Reunión Española de Ciencia y Tecnología de Aerosoles – RECTA 2011, CIEMAT, 27-29 Junio de 2011.



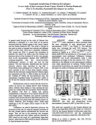
Córdoba-Jabonero, C., M. Sorribas, J.L. Guerrero-Rascado, J.A. Adame, **Y. Hernández**, H. Lyamani, V. Cachorro, M. Gil, L. Alados-Arboledas, E. Cuevas, and B. de la Morena, Saharan dust intrusion monitoring. Part 2: Evaluation of potential dust impact on surface, V Reunión Española de Ciencia y Tecnología de Aerosoles – RECTA 2011, CIEMAT, 27-29 Junio de 2011

EAC2011 Manchester

European Aerosol Conference

4-9 Sept 2011

Córdoba-Jabonero, C., M. Sorribas, J.L. Guerrero-Rascado, J.A. Adame, **Y. Hernández**, H. Lyamani, V. Cachorro, M. Gil, L. Alados-Arboledas, E. Cuevas, and B. de la Morena, Synergetic monitoring of Saharan dust plumes: A case study of dust transport from Canary Islands to Iberian Peninsula. Part 1: Dust detection, identification and vertical structure analysis, European Aerosol Conference (EAC), Manchester (UK) 4-9 September, 2011.



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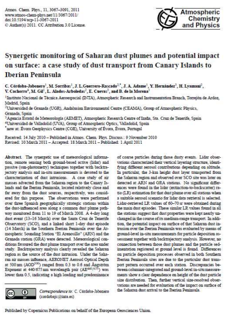
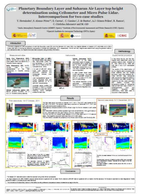


Synergetic monitoring of Saharan dust plumes and potential impact on surface: a case study of dust transport from Canary Islands to Iberian Peninsula

Córdoba-Jabonero, C., Sorribas, M., Guerrero-Rascado, J. L., Adame, J. A., **Hernández, Y.**, Lyamani, H., Cachorro, V., Gil, M., Alados-Arboledas, L., Cuevas, E., and de la Morena, B.: Synergetic monitoring of Saharan dust plumes and potential impact on surface: a case study of dust transport from Canary Islands to Iberian Peninsula, Atmos. Chem. Phys., 11, 3067-3091, doi:10.5194/acp-11-3067-2011, 2011

Publications and Congress Communications, 2011-2014 (2/5)

EAC-2012
Granada
European Aerosol Conference
2-7 Sept 2012



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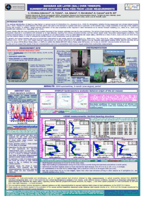

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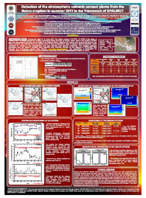
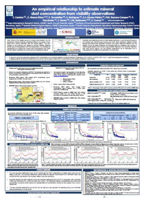


Guerrero-Rascado, J.L., J.A. Bravo-Aranda, F. Wagner, C. Córdoba-Jabonero, F. Molero, D. Lange, M. Granados-Muñoz1, J. Preißler, D. Toledo, A.J. Fernández, M. Sicard, F. Navas-Guzmán, **Y. Hernández**, A.M. Silva, M. Pujadas, A. Comerón, S. Pereira, F. Rocadenbosch, and L. Alados-Arboledas, Detection of the stratospheric volcanic aerosol plume from the Nabro eruption in summer 2011 in the framework of SPALINET, European Aerosol Conference 2012 (EAC 2012), Granada (Spain), 2-7 September, 2012.



Camino C., S. Alonso-Pérez, E. Terradellas, S. Rodríguez, A.J. Gómez, P. M. Romero-Campos, **Y. Hernández**, S. Basart, J. M. Baldasano and E. Cuevas, An empirical relationship to estimate mineral dust concentration from visibility observations, European Aerosol Conference 2012 (EAC 2012), Granada (Spain), 2-7 September, 2012.

Publications and Congress Communications, 2011-2014 (3/5)

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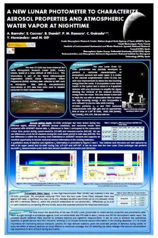
TECO-2012

WMO TECHNICAL CONFERENCE ON METEOROLOGICAL AND ENVIRONMENTAL INSTRUMENTS AND METHODS OF OBSERVATION

Brussels, Belgium, 16-18 October 2012



A. Barreto, E. Cuevas, B. Damiri, P.M. Romero, C. Guirado, **Y. Hernández** and M. Gil, A new Lunar Photometer to characterize aerosol properties and atmospheric water vapor at nighttime,WMO Technical conference o meteorological and environmental instruments and methods of observation, (TECO-2012), Brussels (Belgium), 16-18 October 2012.

Atmos. Meas. Tech., 6, 585–598, 2013
www.atmos-meas-tech.net/6/585/2013/
doi:10.5194/amt-6-585-2013

Atmospheric Measurement Techniques
Open Access

A new method for nocturnal aerosol measurements with a lunar photometer prototype

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Abstract. This paper presents the preliminary results of nocturnal Aerosol Optical Depth (τ_a) and Angström Exponent (α) obtained from a new lunar photometer prototype, trade name Cimel CE-318U. Due to the variation of the moon's illumination inherent to the lunar cycle, the typical Langley-plot Method used in solar photometry to calibrate these instruments cannot be applied. In this paper, we propose three different methods to carry out the lunar-photometer calibration. In order to validate the results, we have selected three events which encompass seven nights and ten days under different atmospheric conditions, including several saharan dust intrusions episodes. Method#1 is introduced in this work as a modification of the usual Langley Method. This technique, called Lunar-Langley Method, requires the extraterrestrial irradiances from a lunar irradiance model, providing similar accuracies on τ_a to those of AERONET ($\pm$ 0.01–0.02). It makes comparable daytime and nighttime measurements. Method#2 consists of transferring the current calibration from a master used by sunphotometers. Its results are again within the limit of accuracy expected for the instrument. Method#3 uses an integrating sphere and the methodology proposed by Li et al. (2008) to determine sky calibration coefficients (C_j) and the instrument's solid angle field-of-view (Ω), respectively. We observe significant τ_a differences between Method#1 and #3 (up to 0.07), which might be attributed to the errors propagation in Method#3. The good results obtained from the comparison against a second CE-318U prototype, and against daytime data from a Precision Filter Radiometer (PFR), constitute a valuable assessment of CE-318U performance. Results of α and its spectral variation ($\delta\alpha$) show good agreement between daytime and nighttime, being able to identify the aerosol properties associated with each event.

1 Introduction

Atmospheric aerosols are known to impact the climate evolution, but they still represent one of the largest uncertainties in climate change studies (IPCC, 2007). The high uncertainty associated with the role played by aerosols in radiative forcing on a global scale makes it necessary to obtain a global ground-based aerosol climatology. In this sense, the Aerosol Robotic Network (AERONET) is nowadays one of the most powerful worldwide tool (Holben et al., 1998). Aerosol Optical Depth (τ_a) at a certain wavelength is the standard parameter measured by sunphotometers such as those operating in AERONET. Spectral dependence of τ_a is mainly driven by the scattering efficiency and can be expressed by means of the classical Angstrom's equation (Angstrom, 1929). In the solar spectrum, the Angstrom exponent (α) is a good indicator of the dominant size of the atmospheric particles. τ_a and α data obtained from AERONET stations are used to provide independent and trustable validation to satellite-based

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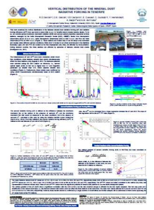
Barreto, A., E. Cuevas, B. Damiri, C. Guirado, T. Berkoff, A. J. Berjón, **Y. Hernández**, F. Almansa, and M. Gil, A new method for nocturnal aerosol measurements with a lunar photometer prototype, Atmos. Meas. Tech. Discuss., 5, 5527-5569, doi:10.5194/amtd-5-5527-2012, 2012.

Publications and Congress Communications, 2011-2014 (4/5)

RICTA Tarragona '14
2nd Iberian Meeting on Aerosol Science and Technology
7-9 July 2014



R. D. García, O. E. García, V. E. Cachorro, E. Cuevas, C. Guirado, **Y. Hernández**, A. Berjón and A. M. de Frutos: " Vertical Distribution of the Mineral Dust Radiative Forcing in Tenerife", 2nd Iberian Meeting on Aerosol Science and Technology RICTA, 2014, Tarragona 7-9 July 2014.

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TECO-2014
Saint Petersburg, Russian Federation, 07-09 July 2014

A. Barreto, E. Cuevas, A. Mortier, P. Goloub, T. Poduin, L. Blarel, V. Choliy and **Y. Hernández**: "Nighttime characterization of AOD and water vapor using lunar photometry. Synergies with Lidar technique", WMO Technical conference o meteorological and environmental instruments and methods of observation, (CIMO TECO-METEOREX, 2014), St. Petersburg (Russian Federation) 7-16 July 2014


Accurate Determination of the TOA Solar Spectral NIR Irradiance Using a Primary Standard Source and the Bouguer–Langley Technique

D. Bolsée · N. Pereira · W. Decuyper · D. Gillotay · H. Yu · P. Sperfeld · S. Pape · E. Cuevas · A. Redondas · Y. Hernandez · M. Weber

D. Bolseé, N. Pereira, W. Decuyper, D. Guillotay, H. Yu, P. Sperfeld, S. Pape, E. Cuevas, A. Redondas, **Y. Hernández**, M. Weber, " Accurate Determination of the TOA Solar Spectral NIR Irradiance Using a Primary Standard Sourse and the Bouger-Langley Technique", Solar Phys, July 2014, Volume 289, Issue 7, pp2433-2457, doi : 10.1007/s11207-014-0474-1, 2014

Publications and Congress Communications, 2011-2014 (5/5)

The MACC-II 2007-2008 Reanalysis: Atmospheric Dust Evaluation and Characterization over Northern Africa and Middle East

E. Cuevas[1], C. Camino[1,2], A. Benedetti[3], S. Basart[4], E. Terradellas[5], J.M. Baldasano[2,4], J.-J Morcrette[3], B. Marticorena[6], P. Goloub[7], A. Mortier[7], A. Berjón[1], Y. Hernández[1], M. Gil-Ojeda[8], M. Schulz[9]

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[7]Laboratoire d'Optique Atmosphérique, Université Lille 1, Lille, France

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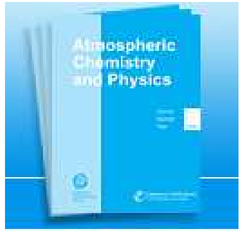
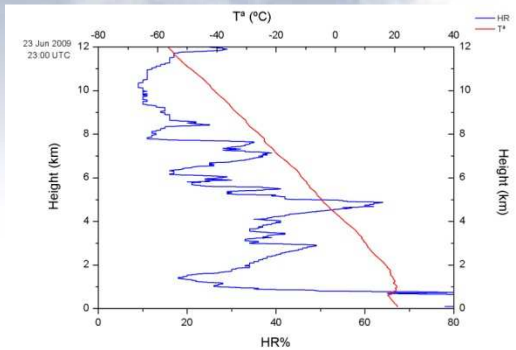
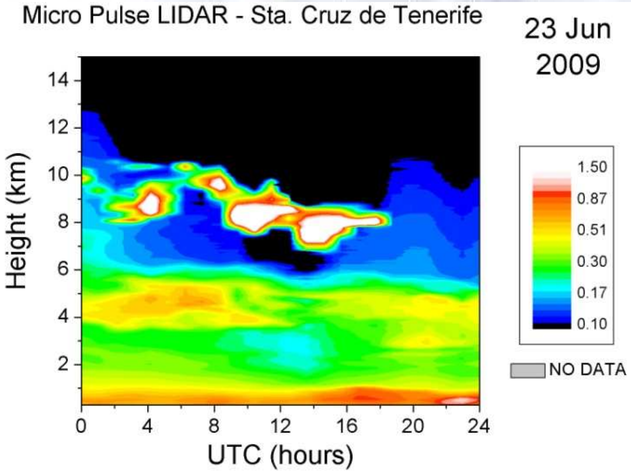
Abstract

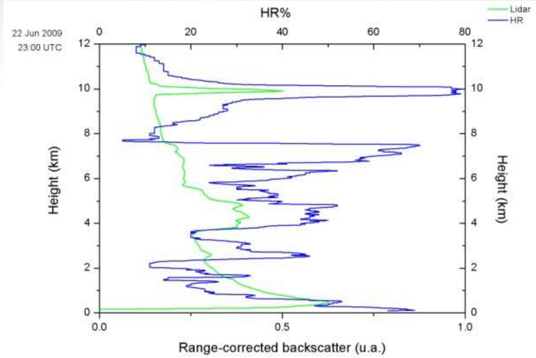
In the present work, atmospheric mineral dust from a MACC-II short reanalysis run for two years (2007-2008), has been evaluated over Northern Africa and Middle East using satellite aerosol products (from MISR, MODIS and OMI satellite sensors), ground-based AERONET data, in-situ PM10 concentrations from AMMA, and extinction vertical profiles from two ground-based lidars and CALIOP. The MACC-II aerosol optical depth (AOD) spatial and temporal (seasonal and interannual) variability shows good agreement with those provided by satellite sensors. The capability of the model to reproduce AOD, Ångström exponent (AE) and dust optical depth (DOD) from daily to seasonal time-scale is quantified over twenty-six AERONET stations located in eight geographically distinct regions by using statistical parameters. Overall DOD seasonal variation is fairly well simulated by MACC-II in all regions, although the correlation is significantly higher in dust transport regions than in dust source regions. The ability of MACC-II in reproducing dust vertical profiles has been assessed by comparing seasonal averaged extinction vertical profiles simulated by MACC-II under dust conditions with

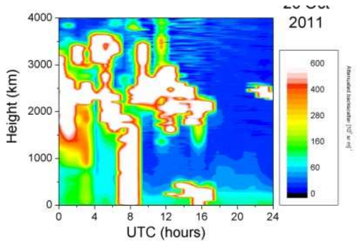


Atmospheric Chemistry and Physics









Thank you for your attention